DYNAMIC – Ad-hoc network-wide traffic detection

German Aerospace Center
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German Aerospace Center (DLR)

Research Institution
- Aeronautics
- Space
- Energy
- Transport
- Defense and Security

Approx. 8000 employees across 33 institutes and facilities at 16 sites

Space Agency

Project Management Agency

Total income 2015: 891 Mio.€ (research, operations, management)
Motivation
Hazardous materials accident on motorway BAB 27 (19.05.2011)
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- Travel time increase for individual traffic and rescue services
- Despite special rights of way
- General consequences on:
  - Accessibility of critical infrastructures (hospitals, etc.)
  - Travel times of ambulance vehicles resp. legal time limit
  - Alerting and lead up of additional forces

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 CET</td>
<td>Closure of BAB 27 in both directions</td>
</tr>
<tr>
<td>During the day</td>
<td>Massive, region-wide congestions</td>
</tr>
<tr>
<td>21:30 CET</td>
<td>Reopen in direction north-west</td>
</tr>
<tr>
<td>24:00 CET</td>
<td>Reopen in direction south-east</td>
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</tbody>
</table>

Travel time at 20:00 CET: 50 min (usually: 14 min)
Vabene++
Traffic Monitoring
using radio based technologies (e.g. Bluetooth, WiFi)

- **Principle**: Detection of mobile devices with activated Bluetooth interface (e.g. smartphones)
- **Relevant information**: time, position, unique identifier (= anonymized MAC address) → recognition at different points in network enables determination of travel times, velocities, trajectories, queuing length
- **Usage**: Stationary Bluetooth sensors are already in action for
  - Check-in times at airports
  - Visitor flow and waits in front of retail shops
  - Passenger flow analysis in public transport
  - Visitor counts at events (fairs, exhibitions, …)
Traffic Monitoring using Bluetooth-Floating Car Observer („DYNAMIC“)

**DYNAMIC principle**

- Mobile Bluetooth monitoring (combines FCD and FCO)
- Observers are part of traffic flow while they detect other traffic objects via Bluetooth
- Enables reconstruction of trajectories and travel times
Applications
Urban mobile traffic monitoring (1)

Test field:
• Berlin Adlershof Science City (WISTA) - area of 4.2 km², home of 1,013 companies and scientific institutions
• 16 mobile sensors (different modes: 4 cars, 4 bicycles, 8 pedestrians)
• Duration: 2 hours

Goals:
• Proof of concept
• Performance analysis of sensors based on different traffic modes
• Frequency of detections and recognitions
• Generating trajectories of detected devices
Applications
Urban mobile traffic monitoring (2)

Results:
• 8000 detected objects in total:
  • 2000 objects with unknown traffic mode (at least 831 were moving objects due to recognitions)
  • 6000 objects were detections of the observers themselves

Detection rate (DYNAMIC vs. Loops):
• stationary Bluetooth sensors detect 30% of overall traffic
• mobile observers detect about 23% of overall traffic

- system performs best using pedestrians as observers and observed traffic objects
→ low speeds enable better detection probability and localization
Applications
Mobile pedestrian monitoring (1)

Test field:
- Beuth University of Applied Sciences
- 8 stationary Bluetooth sensors
- 8 mobile Bluetooth sensors (specific smartphone application)
- Duration: 14 days (mobile measures: 2 hours/day)

Goals:
- Monitoring pedestrian flow
- Path utilization assessment
- Generating trajectories from devices which were recognized several times
Applications
Mobile pedestrian monitoring (2)

Results:
• Self localization using GPS works (= Floating 'Car' Data)
• Indirect external localization based on Bluetooth monitoring works as well
  • Monitoring of activated Bluetooth-enabled devices (e.g. Smartphones)
  • Monitoring of other mobile observers

→ Added value: no stationary infrastructure
→ thus only minimal costs
Applications
Traffic monitoring at major events (1)

Test field:
• Wacken Open Air Festival 2015
• Ca. 80,000 visitors - approx. 50,000 persons arrived in ca. 24,000 cars
• 9 stationary Bluetooth sensors at neuralgic points along access roads
• mobile detection at festival site was not allowed by the organizer

Goals:
• Monitoring traffic situation on access roads during festival
• Depiction of travel times on access roads
Applications
Traffic monitoring at major events (2)

Results:
• Bluetooth based traffic monitoring was helpful to get an impression of actual traffic situation

31.07.2015, 05:21 p.m.
Conclusion

**DYNAMIC characteristics**

- Traffic participants and their smart devices as **multisensory platform** for traffic detection
  - Detection is **independent from traffic mode** (vehicles, pedestrians and bikes can be detected)
- **Rising equipment rate** of devices with detectable communication services (Bluetooth, WiFi, ...)
  - more and more travelers carry **detectable smart devices** (e.g. Smartphones)
  - **20 - 40 %** motorized vehicles have detectable devices on board
- floating car observers equipped with **low-cost detection** units
  - detector price ~200€ (vs. ~10.000€ inductive loop)
- **No** intrusive **stationary infrastructure** required
- **Ad hoc installation** enables rapid deployment
  - traffic management in **specific occasions** (e.g. roadworks, bypass, huge events)
  - hazard management with **minimal preparation time**
- More **accurate OD** and **route choice** extraction (also sub road network!)
Future Prospects

- Currently proof of technology
- Further field tests are carried out / planned
  - **Taxi Fleet in Berlin (01 June - 31 August)**
    - broad-scale campaign with 30 equipped taxis
    - Goals: area-wide traffic monitoring, travel times and velocities, OD
  - **Wacken 2016 (04 - 06 August)**
    - mobile traffic monitoring at festival site is planned (staff equipped with smartphones)
    - Goals: pedestrian flow monitoring and path usage
- In 2017 operationalising
  - Development of market-ready product
  - Further field tests (e.g. football game)
Contact

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